THE STRUCTURE OF ^{18}Ne AND THE BREAKOUT OF THE HOT CNO CYCLE

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The nuclear structure of ^{18}Ne plays an important role in explosive hydrogen burning events. Both the ^{14}O(α,p)^{17}F and ^{17}F(p,γ)^{18}Ne reactions proceed predominantly through resonances in ^{18}Ne. ^{14}O(α,p)^{17}F plays an important role in the breakout from the astrophysical hot CNO cycle and ^{17}F(p,γ)^{18}Ne plays the critical role in determining the ratio of A=17 to A=18 nuclides produced in explosive hydrogen burning. Ideally these rates would be determined by measuring ^{14}O+α and ^{19}F+p directly, but that would require an enormous effort since ^{14}O($t_{1/2}$=71 s) and ^{17}F($t_{1/2}$=65 s) are unstable. Another alternative is to determine the rate by measuring the appropriate resonance parameters in ^{18}Ne. There are two light ion reactions with which the structure of ^{18}Ne can be studied with high resolution, ^{20}Ne(p,t) and ^{16}O(^{3}He,t). We studied the excitation range of interest using the ^{16}O(^{3}He,t) reaction at the University of Washington and the ^{20}Ne(p,t) reaction at IUCF using the K600 spectrometer. We report on the latter here.

We measured the ^{20}Ne(p,t)^{18}Ne reaction at 6° and 11° using a 90 MeV proton beam and the K600 spectrometer in order to determine the excitation energies and, where possible, the natural widths of levels between 6 and 8 MeV of excitation, and in an attempt to confirm the observation[1] of the $J^{\pi} = 3^{+}$ level at 4.56 MeV. Figure 1 shows the spectrum taken at 6°. Critical to the measurement was the target made by implanting 7 μg/cm^2 ^{20}Ne into natural 40 μg/cm^2 carbon foils.[2] This enabled us to have a 25-30 keV resolution which would not have been possible with a standard gas cell.

The analysis of these data is not complete, but preliminary results show two interesting points. First we saw only two levels in the 6.0-6.5 MeV excitation energy range, the range critical to the ^{14}O+α reaction (Fig. 1), at 6.30 and 6.35 MeV of excitation. These two levels and one other at 6.15 MeV were seen in this excitation range in ^{16}O(^{3}He,n)^{18}Ne (see Ref. 3) and also in a heavy-ion reaction of ^{12}C(^{12}C,^{6}He)^{18}Ne (see Ref. 4). There are only three levels in the well-studied analog nucleus ^{18}O in this excitation range. They have $J^{\pi}=1^{-}$, 2^{-} and 3^{-}. Considering that the ^{20}Ne(p,t) reaction strongly prefers to populate natural parity states, we tentatively conclude that the 6.15 MeV level in ^{18}Ne not seen in

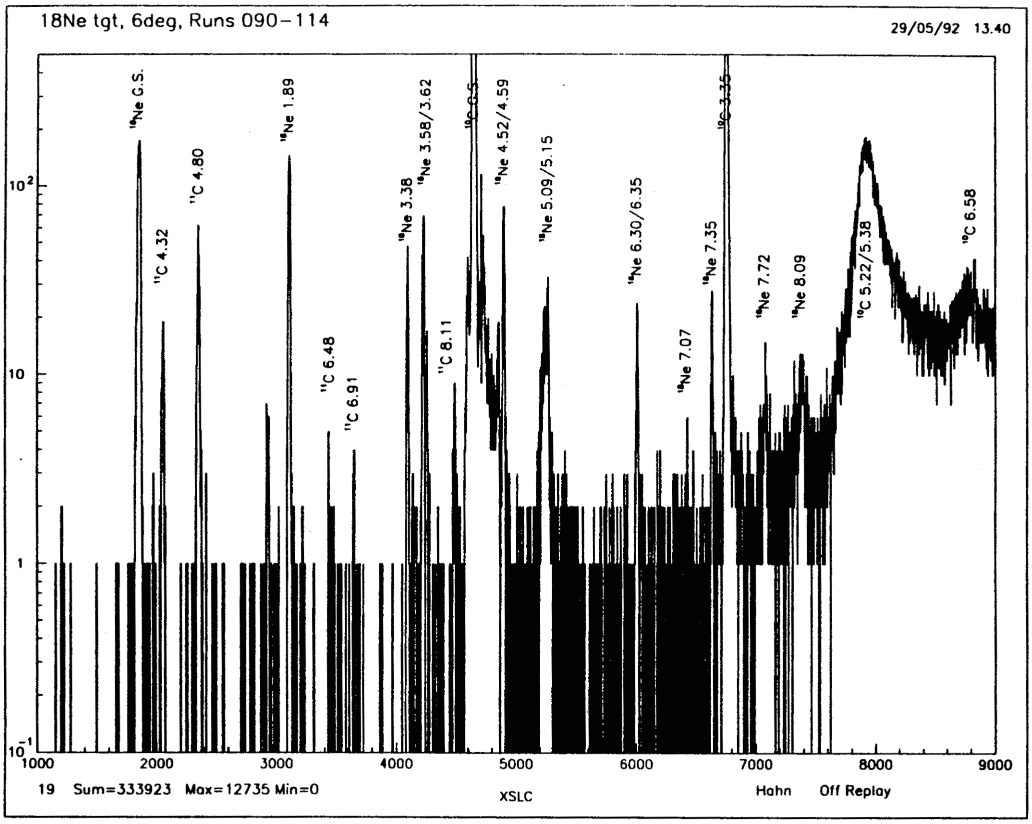

Figure 1. The ^{20}Ne(p,t)^{18}Ne spectrum taken at a beam energy of 90 MeV and an angle of 6°. The peaks resulting from ^{20}Ne(p,t)^{18}Ne are labeled by the excitation of the state in ^{18}Ne populated. Peaks that result from ^{12}C(p,t)^{10}C and ^{13}C(p,t)^{11}C in the target are labeled with ^{10}C and ^{11}C respectively.

(p,t) is the analog of the 2^- in ^{18}O. This is in disagreement with the conclusions of Garcia who tentatively assigns $J^\pi=1^-$ to this level based on Coulomb shift calculations. Since Garcia calculates that the 1^- level dominates the ^{14}O+α reaction rate, these (p,t) results require a recalculation of that reaction rate which is now in progress.

Secondly we do not see any evidence for the 3^+ level at 4.56 MeV, which is not surprising considering the strong preference the (p,t) reaction has for populating natural parity levels.

1. A. Garcia *et al.*, Phys. Rev. **C43**, 2012 (1991).
2. M. Smith *et al.*, Nucl. Phys. **A536**, 333 (1992).
3. A. Garcia, Thesis, University of Washington 1991.
4. K.I. Hahn, Thesis, Yale University (in progress) 1992.